Mid-Rapidity Neutral Pion Production in Proton-Proton Collisions at $\sqrt{s}$=200 GeV

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Particle production at large transverse momenta, p_T, in hadronic reactions provides an important testing ground for perturbative Quantum Chromodynamics (pQCD). Successful description of measured particle p_T spectra with pQCD is necessary for interpretation of spin asymmetries in terms of polarized gluon and polarized quark distributions in the nucleon[1]. It also provides a reference needed to quantify nuclear effects in hadron production in heavy ion collisions[2].

First PHENIX results on inclusive π^0 production from proton-proton collisions at $\sqrt{s}$ = 200 *GeV* in the 1–13 GeV/c π^0 p_T range from Year-2002 RHIC run (Run2) has been published[3]. The analyzed data corresponded to ∼40 nb^{-1} integrated luminosity. In this paper we present an update of PHENIX π^0 cross section measurements based on ∼ 2 pb^{-1} data accumulated by PHENIX during the Year-2005 RHIC run (Run5). It enabled to extend the p_T range and to significantly decrease the statistical uncertainties of the measurements.

Analysis method for π^0 cross section measurement is described in details in ref[3]. $\pi^0 \rightarrow \gamma\gamma$ decays were detected using the electromagnetic calorimeter (EMCal)[4]. EMCal locates at a radial distance of ∼5 m from the beam line. Each of the towers in the calorimeter subtends $\Delta\phi\times\Delta\eta \sim 0.01\times0.01$, thus ensuring that the two photons from a decayed π° were clearly resolved up to a p_T of 12 GeV/c. At higher p_T the measured π^0 yields should be corrected for two photon merging probability, which was carefully studied with EMCal Monte Carlo simulation and cross checked vs Test Beam data results. The raw π^0 yields were also corrected for the p_T smearing arising from the EMCal resolutions and the steeply falling spectrum; and for the losses due to the disabled towers and the incomplete azimuthal coverage.

Low p_T part of π^0 spectrum was obtained from "minimum bias" (MB) data sample triggered by beam-beam counters (BBC)[5]. BBCs locate along the beam line at ±1.44 m from the nominal interaction point and subtended the pseudorapidity range ±(3.0-3.9) with full azimuthal coverage. The BBC trigger cross section in Run5 was traced from Run2 and was found to be 22.9±2.2 mb. Higher p_T π^0 measurements were done using EMCal based high p_T photon trigger[3] in coincidence with MB trigger. Its efficiency reached a plateau of ∼ 90% at π^0 p_T of ∼4 GeV/c. Since only a fraction of inelastic proton-proton collisions produce particles which enter BBCs, the MB trigger condition biases the recorded data sample, so only a fraction of the inclusive π^0 yield was detected. This fraction was determined with another photon trigger, which was formed without MB trigger requirements. This fraction was found to be ∼ 0.78, independent of π^0 p_T.

Fig. 1 shows the π^0 cross section results in the p_T range from 1 to 20 GeV/c. NLO pQCD calculations[6][7] are consistent with the data over the full range of p_T.

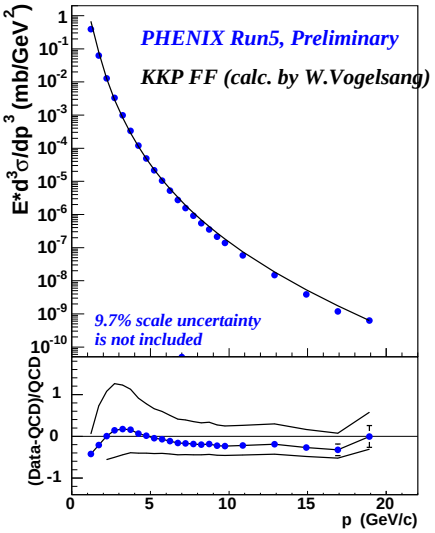

Fig. 1. Upper: The invariant differential cross section for inclusive π° production (points) and the results from NLO pQCD calculations[6] with equal renormalization and factorization scales of p_T using the "Kniehl-Kramer-Pötter" sets of fragmentation functions[7]. Bottom: The relative difference between the data and the theory with scales of $p_T/2$ (lower curve), p_T, and $2p_T$ (upper curve). In all figures, the normalization error of 9.7% is not shown.

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